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Standard Methods of Testing
SLAB FLEXIBLE URETHANE FOAM[1]

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These methods were prepared jointly by the American Society for Testing and Materials and The Society of the Plastics Industry.

ε NOTE 1—Table 1 was editorially deleted in February 1972.
NOTE 2—Editorial changes were made throughout in April 1973.
NOTE 3—Editorial changes were made throughout in November 1973.

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1. Scope

1.1 These methods apply to slab flexible cellular foams known as urethane foam. Urethane foam may be generally defined as an expanded cellular product produced by the interaction of active hydrogen compounds, water, and isocyanates.

NOTE 1—These methods have been developed primarily for slab foam. Tests for molded foam are covered in ASTM Methods D 2406, Testing Molded Flexible Urethane Foam.[2]

1.2 This document covers test procedures only. The numerical specifications will be developed as separate documents by appropriate groups based on end use, such as automotive, etc.

1.3 Unless specifically stated otherwise between the vendor and the purchaser, all tests shall be made in accordance with the methods specified in Sections 5 to 95 which include test procedures for the following:

	Sections
Basic Tests:	
Steam Autoclave Test	5 to 11
Constant Deflection Compression Set Test	12 to 18
Load Deflection Tests	
Method A, Indentation (to specified deflections)	19 to 25
Method B, Indentation (to specified loads)	26 to 31
Air Flow Test	32 to 38
Suffix Tests:	
Compression Load Deflection Test (Suffix D)	39 to 44
Dry Heat Test (Suffix A)	45 to 51
Fatigue Test (Suffix H)	52 to 68
Density Test (Suffix W)	69 to 74
Tear Resistance Test (Suffix G)	75 to 81
Tension Test (Suffix T)	82 to 88
Resilience (Ball Rebound) Test (Suffix R)	89 to 95

2. Test Conditions

2.1 Tests shall be conducted under known conditions of temperature and humidity or as specified in the individual test procedure. After preflexing in cases of dispute, the tests shall be made at a temperature of 23 ± 1.1 C (73.4 ± 2 F) and in an atmosphere of 50 ± 2 percent relative humidity. The product shall be conditioned, undeflected, and undistorted at the temperature and humidity of test for at least 12 h before being tested.

2.2 It is recommended for referee purposes that all tests shall be performed 96 h or more after the foam has been manufactured.

3. Sampling

3.1 When possible, the completed manufactured product shall be used for the test specified. Representative samples of the lot being examined shall be selected at random as required.

3.2 When it is necessary or advisable to obtain specimens from the article, as in those cases where the entire sample is not required or adaptable for testing, the method of cutting and the exact position from which specimens are to be taken shall be specified. The density and the state of cure may vary in different parts of the finished product, especially if the article is of complicated shape or of varying thickness and these factors affect the physical properties of the specimens. Also, the density is affected by the number of cut surfaces as opposed to the number of skin-covered surfaces on the specimen. If a test specimen is die cut, sufficient time should be allowed to complete recovery of the thickness across the full width of the specimen.

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[1] These methods are under the jurisdiction of ASTM Committee D-11 on Rubber and Rubber-Like Materials and is the direct responsibility of Subcommittee D-11.33 on Flexible Cellular Materials.

Current edition effective April 16, 1971. Originally issued 1958. Replaces D 1564 – 69.

[2] *1974 Annual Book of ASTM Standards*, Part 38.

3.3 When the finished product does not lend itself to testing or to the taking of specimens because of complicated shape, small size, metal or fabric inserts, adhesion to metal, or other reasons, test slabs as agreed upon between the manufacturer and the purchaser shall be prepared.

3.4 When differences due to the difficulty in obtaining suitable specimens from the finished part arise, the manufacturer and the purchaser may agree on acceptable deviations. This can be done by comparing the results of standard specimens and those obtained on actual parts.

4. Measurements of Test Specimens

4.1 The length and width shall be measured with a scale or tape. Care shall be taken not to distort the foam.

4.2 Thickness up to and including 25 mm (1 in.) shall be measured using a dial-type gage with a minimum foot area of 650 mm^2 (1 $in.^2$). Pressure of the dial foot shall be held to 140 ± 35 Pa (0.028 ± 0.007 psi) (Note 2). Thicknesses over 25 mm (1 in.) may be measured with a dial gage, a sliding caliper gage, or as specified in 4.1. When a sliding caliper gage is employed, the gage setting shall be made with the gage out of contact with the foam. The specimen shall be passed through the previously set gage and the proper setting shall be the one when the measuring faces of the gage contact the surfaces of the specimen without compressing it.

NOTE 2—For very soft foams having ILD values less than 53 N/3.2 dm^2 (12 lb/50 $in.^2$), the pressure on the dial foot shall not exceed 70 Pa (0.01 psi).

4.3 The scale, tape, or gage shall be graduated so as to permit measurements within ±1 percent of the dimensions to be measured.

4.4 Results reported shall be the average of a minimum of three measurements.

BASIC TESTS

STEAM AUTOCLAVE TEST

5. Summary of Method

5.1 This test consists of treating the foam specimen in a low-pressure steam autoclave and observing the effect on physical properties of the specimen. The test consists of two sets of conditions:

5.1.1 Condition A, 3 h at 105 C (220 F) (normally used for polyester foam).

5.1.2 Condition B, 5 h at 120 C (250 F) (normally used for polyether foam).

6. Apparatus

6.1 *Steam Autoclave*, or similar vessel, that is thermostatically controlled to ±3 C (±5.4 F) and capable of withstanding gage pressures up to 140 kPa (20 psig).

7. Test Specimens

7.1 The test specimens shall be 50 by 50 by 25 mm (2 by 2 by 1 in.) unless otherwise specified. It is recommended that the specimens from each different sample be tested separately in order to avoid possible contamination.

8. Number of Specimens

8.1 Three specimens per sample shall be tested. The values reported shall be the mean of those observed. If any value deviates more than 20 percent from this mean, two additional specimens shall be tested and the mean for all five values shall be reported.

9. Procedure

9.1 Dry the specimen initially for 3 h/25 mm (1 in.) of thickness at 70 ± 1.1 C (158 ± 2 F) in a mechanically convected dry-air oven.

9.2 Allow the specimen to come to equilibrium, after removal from the oven, for at least 1 and no more than 24 h under known temperature and humidity conditions (ambient).

9.3 Test the specimens for compression load deflection as prescribed in Sections 39 to 44.

9.4 Fill the autoclave with fresh-distilled water to a level 50 mm (2 in.) above the bottom of the autoclave. Set the thermostat control at the desired conditions of test, which are between 104.4 ± 3 and 121.1 ± 3 C (216 ± 5 and 254 ± 5 F). Based on pressure, this range is from 7 to 28 kPa (1 to 4 psig) and from 83 to 110 kPa (12 to 16 psig). Allow the autoclave to heat until the water boils. Place the specimens on edge on a rack in the inside container so that one specimen does not touch another or any metal except at the supporting surface. Place the container inside the autoclave and close and tighten the top. Leave the safety valve open until all the air is out of the autoclave. This is apparent when steam begins blowing out of the ports on the safety valve. Close the valve 2 min after the appearance of steam and take the zero time of the heat at this point.

9.5 After the exposure period, turn off the heat, release the steam pressure, and remove the specimens without delay. Dry the specimens for 3 h/25 mm (1 in.) of thickness at 70 ± 1.1 C (158 ± 2 F) in a mechanically convected dry-air oven. Allow them to come to equilibrium, after removal from the oven, for at least 2 and no more than 24 h under known temperature and humidity conditions (ambient).

9.6 Test each specimen for compression load deflection as prescribed in Sections 39 to 44 using the original specimen thickness in determining the deflection and for compression set as prescribed in Sections 12 to 18.

10. Calculations

10.1 Calculate the percentage compression load deflection loss, as follows:

$$\text{Compression load deflection loss, percent} = [(L_o - L_f)/L_o] \times 100$$

where:

L_o = original compression load deflection, and

L_f = final compression load deflection after steam autoclave test.

10.2 Calculate the compression set in accordance with Section 17.

11. Report

11.1 The report shall include the following:

11.1.1 Whether Condition A or Condition B is used,

11.1.2 Percentage loss of compression load deflection, and

11.1.3 Compression set, designating it as steam autoclave test compression set.

COMPRESSION SET TEST[3]

Method B. Constant Deflection

12. Summary of Method

12.1 This method consists of deflecting the foam specimen under specified conditions of time and temperature and noting the effect on the thickness of the specimen.

13. Apparatus

13.1 *Compression Device*, consisting of two or more flat plates arranged so the plates are held parallel to each other by bolts or clamps and the space between the plates is adjustable to the required deflection thickness by means of spacers.

14. Test Specimens

14.1 The test specimens shall have parallel top and bottom surfaces and essentially perpendicular sides.

14.2 Specimens from uncored stock shall be 50 by 50 by 25 mm (2 by 2 by 1 in.) unless otherwise specified. Specimens less than 25 mm in thickness shall be plied up, without the use of cement, to a 25-mm thickness.

14.3 Specimens from cored stock shall be of such size that the coring does not appreciably affect the test result. They shall have a minimum top surface area of 1 dm^2 (16 in.^{2}). The thickness shall be no greater than 75 percent of the minimum top dimension.

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[3] Method A, Constant Load Compression Set, will be developed when required.

15. Number of Specimens

15.1 Three specimens per sample shall be tested. The values reported shall be the mean of those observed. If any value deviates more than 20 percent from this mean, two additional specimens shall be tested and the mean for all five values shall be reported.

16. Procedure

16.1 Perform the entire test procedure under the following conditions: conduct all measurements, conditioning, and recovery of the specimen at 23 ± 1.1 C (73.4 ± 2 F) and in an atmosphere of 50 ± 2 percent relative humidity. The oven conditions shall be 70 ± 1.1 C (158 ± 2 F) and 5 ± 1 percent relative humidity.

NOTE 3—This condition of relative humidity may be achieved by placing an oven at 70 ± 1.1 C (158 ± 2 F) in an atmosphere maintained at 23 ± 1.1 C (73.4 ± 2 F) and 50 ± 2 percent relative humidity.

16.2 Measure the test specimen in accordance with the procedure described in Section 4.

16.3 Place the test specimen in the apparatus and deflect it to either 50 ± 1 or 90 ± 1 percent of its thickness, or any other deflection depending on the value called for in the specifications.

16.4 Within 15 min place the deflected specimen and the apparatus in the mechanically convected air oven for a period of 22 h, then remove the apparatus.

16.5 Remove the specimen immediately from the apparatus and measure it in accordance with the procedure described in Section 4 after 30 min + 10 or − 0 min recovery.

17. Calculations

17.1 Calculate the constant deflection compression set, expressed as a percentage of the original thickness, as follows:

$$C_t = [(t_o - t_f)/t_o] \times 100$$

where:

C_t = compression set expressed as a percentage of the original thickness,
t_o = original thickness of test specimen, and
t_f = final thickness of test specimen 30 min + 10 or − 0 min after removal from the apparatus.

17.2 Calculate the constant deflection compression set, expressed as a percentage of the original deflection, as follows:

$$C_d = [(t_o - t_f)/(t_o - t_s)] \times 100$$

where:

C_d = compression set expressed as a percent of the original deflection,
t_o = original thickness of test specimen,
t_s = thickness of spacer bar used, and
t_f = final thickness of test specimen 30 min + 10 or − 0 min after removal from the apparatus.

18. Report

18.1 Report compression set as C_t or C_d.

LOAD DEFLECTION TESTS

Method A. Indentation (to Specified Deflections)

19. Summary of Method

19.1 This will be known as the indentation load deflection test and the results as the ILD values.

19.2 This test consists of measuring the load necessary to produce 25 percent and 65 percent or other designated indentations in the foam product.

20. Apparatus

20.1 An apparatus having a flat circular indentor foot 3.2 dm^2 (50 in.^{2}) in area, connected by means of a swivel joint to a load measuring device and mounted in such a manner that the product or specimen can be deflected at a speed of 0.4 to 6.3 mm/s (1.0 to 15 in./min). The apparatus shall be arranged to support the specimen on a level horizontal plate which is perforated with 6.5-mm (0.24 to 0.26-in.) holes on 20-mm (0.75-in.) centers to allow for rapid escape of air during the test.

21. Test Specimens

21.1 The test specimen shall consist of the entire product sample or a suitable portion of it, except that in no case shall the specimen have dimensions less than 380 by 380 by 20 mm (15 by 15 by 0.75 in.). Specimens less than 20 mm thick shall be plied up, without the use of cement, to a minimum of 20 mm.

22. Number of Specimens

22.1 One specimen shall be tested.

23. Procedure

23.1 Place the test specimen in position on the supporting plate of the apparatus. In case the product has one side cored or honeycombed, this face shall rest on the perforated plate. The specimen position shall be such that whenever practicable the indentation will be made at the center of all articles, except where another location is agreed upon by the manufacturer and the buyer.

23.2 Preflex the area to be tested by lowering the indentor foot twice 75 to 80 percent of the full part thickness at a rate of 2.5 to 38 cm (1 to 15 in.)/min. Mark the location of the test area with a pen by circumscribing the indentor foot while under a 454-gf (1-lbf) load. Allow the specimen to rest 6 ± 1 min after the preflex.

23.3 Bring the indentor foot into contact with the specimen and determine the thickness after applying a total preload of 454 gf (1 lbf) (Note 4) of the area under the indentor foot. Compress the specimen at 5 cm (2 in.)/min. 25 percent of this thickness and observe the final load in grams or kilograms (or pounds) after 1 min. Without removing the specimen increase the deflection to 65 percent deflection and again observe the final load.

NOTE 4—For super-soft foam, a reduction of pressure on the indentor foot shall be allowed.

24. Report

24.1 Report the result in newtons per 3.2 dm^2 or pounds-force per 50 in.^{2} required for 25 and 65 percent indentation (Note 5). These figures are known as the 25 percent and 65 percent ILD values, respectively. Report also length, width, and thickness of the specimen and the ratio of 65 percent to 25 percent ILD values.

NOTE 5—Indentation deflection tests, other than 25 and 65 percent, as well as a 25 percent return value, may be specified as agreed upon between the manufacturer and the purchaser.

25. Precision

25.1 The precision of this method in an interlaboratory comparison is within ±5 percent at 25 percent deflection and ±10 percent at 65 percent deflection.

Method B. Indentation (to Specified Loads)

26. Summary of Method

26.1 This will be known as the indentation residual gage load and the results as the IRGL values.

26.2 Cellular foam products have been traditionally checked for load deflection by determining the load required to effect a 25 percent deflection. In seating, on the other hand, the interest is in determining how thick the padding is under the average person. Two measurements are called for: to meet the requirements of this method, the load deflection is determined by measuring the thickness of the pad under fixed loads of 454 gf, 11.4 kgf, and 22.7 kgf (1, 25, and 50 lbf) on a 3.2 dm^2 (50 in.^{2}) circular indentor foot.

27. Apparatus

27.1 An apparatus having a flat circular indentor foot 3.2 dm^2 (50 in.^{2}) in area and loaded through a swivel joint with loads of 454 gf (1 lbf), 11.4 kgf (25 lbf), and 22.7 kgf (50 lbf), shall be mounted over a level horizontal platform which is perforated with 0.64 cm (0.25 in.) holes on 20 mm (0.75 in.) centers to allow for rapid escape of air during test. The distance between indentor foot and platform shall be variable to compress the specimen under test at a speed of 5 to 20 cm (2 to 8 in.)/min for deflection measurements and is equipped with a device for measuring distance between plates.

28. Test Conditions

28.1 When possible, the completed manufactured product shall be used. In the case of tapered cushions, location of area for measurement is to be agreed upon by parties concerned. In the case a finished part is not feasible for test, 38 by 38-cm (15 by 15-in.) specimens of an average thickness are to be cut from the cushion.

29. Number of Specimens

29.1 One specimen shall be tested.

30. Procedure

30.1 Test the whole test specimen or a minimum area of 38 by 38 cm (15 by 15 in.). Preflex twice to a 10-kPa (1.5-psi) loading. This corresponds to 34 kgf on 323 cm^2 indentor foot at 20 cm/min (75 lbf/50 $in.^2$ indentor foot at 8 in./min). Allow to rest 6 ± 1 min. Position in test apparatus with any coring, honeycombing, or slotting resting on perforated bottom plate.

30.2 Bring the indentor foot into contact and determine the thickness of the specimen with the 4.5 N (1 lbf) load on the 3.2 dm^2 (50 $in.^2$) indentor foot.

30.3 Apply the 11.35 kgf (25 lbf) load at 5 cm (2 in.)/min to the indentor foot and compress the specimen until the load is carried by the specimen. Determine the thickness at 11.35 kgf after maintaining the load for 1 min.

30.4 Without removing the specimen apply the 22.7 kgf (50 lbf) load to the indentor foot and further compress the pad until this load is carried. After 1 min under load, observe the thickness of the pad at the 22.7 kgf loading.

30.5 Finally reduce the indentor foot load to 11.35 kgf and allow the specimen to expand at the 5 cm/min (2 in./min) rate until it is just carrying the load. Maintain for 1 min and record the specimen thickness.

31. Report

31.1 Report the specimen thickness after 1 min at 454 kgf (1 lbf), 11.4 kgf (25 lbf), 22.8 kgf (50 lbf), and 11.4 kgf (25 lbf) on return. These figures are known as the IRGL values, respectively.

AIR FLOW TEST

32. Scope

32.1 The air flow test measures the ease with which air passes through a cellular structure. Air flow values may be used as an indirect measurement of certain cell structure characteristics. The test consists of placing a flexible foam specimen in a cavity over a vacuum chamber and creating a specified constant air-pressure differential. The rate of flow of air required to maintain this pressure differential is the Air Flow Value.

33. Definitions

33.1 *air flow value*—the volume of air per minute at standard temperature and pressure required to maintain a constant pressure differential of 125 Pa (0.5 in. of water) across a flexible foam specimen approximately 50 by 50 by 25 mm (2 by 2 by 1 in.).

33.2 *air flow parallel to foam rise*—the air flow value obtained when the air enters and leaves the mounted specimen parallel to foam rise.

33.3 *air flow perpendicular to foam rise*—the air flow value obtained when the air enters and leaves the specimen perpendicular to foam rise.

34. Apparatus

34.1 A schematic drawing of the apparatus including the vacuum chamber, manometer, air flowmeters, blower, and voltage control is shown in Fig. 1.[4]

34.2 *Vacuum Chamber*, consisting of a pot approximately 130 mm (5 in.) in diameter and 150 mm (6 in.) high with provision for mounting the foam specimen and fittings for the manometer and air exhaust. The specimen mount cavity may be either 50.0 ± 0.05 by 50.0 ± 0.05 by 25.0 ± 0.05 mm or 1.980 ± 0.002 by 1.980 ± 0.002 by 1.000 ± 0.002 in. in size. Four foam support vanes approximately 1 mm ($^1/_{16}$ in.) thick and 12.5 mm (0.5 in.) high shall be placed under the opening to prevent the foam from being pulled into the vacuum chamber. The vanes shall be spaced 12.5 mm (0.5 in.) on center from each other and also centered relative to the bottom of the cavity opening. The manometer fitting shall enter a 1-mm ($^1/_{16}$-in.) hole midway along the side of the chamber. A 25-mm (1-in.) pipe fitting shall be used as the exhaust outlet from the center of the bottom of the chamber.

34.3 *Manometer*, calibrated from 0 to 250 Pa (0 to 1 in. of water) and having an accuracy of ±2 percent is required. An inclined oil manometer with graduations of 2 Pa or 0.01 in. of water is recommended. A level mounted on the oil manometer shall be used to maintain the calibration factor. A trap shall be provided on the liquid side of the manometer for accidental excess vacuum. A plunger in the fluid reservoir shall be used to set the zero point of the "level" manometer. Zero setting readings should be taken only after the indicating fluid has had a minimum equilibrium time of 2 min. Longer times may be required if the indicating fluid has been splashed into the trap.

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[4] A suitable Air Flow Apparatus is available from Custom Scientific Instruments, Whippany, N. J.

34.4 *Flowmeters and Blower*—Low-pressure-drop air flowmeters accurate to ±2 percent shall be used for air flow measurements. A given flowmeter should not be used for values less than 10 percent of full scale. Air flowmeters with at least 250-mm (10-in.) scales are recommended. Since the flowmeter calibration is temperature- and pressure-dependent, the use of the apparatus under ambient conditions can result in erroneous readings. In cases of dispute the apparatus should be used under standard conditions of 23 C (73.4 F) and 100 kPa (1 atm pressure) or else a suitable calibration correction applied. Flowmeters that range from 0 to 0.01 m^3/s or 0 to 25 ft^3/min will cover a wide range of foam cell structures but a lesser range may be used.[5] Actual flow is adjusted by a combination of valve restriction and blower speed. The two-way valves shall be mounted on the output side of the flowmeter to maintain the pressure drop across the flowmeter constant at any given flow level. A vacuum cleaner type unit may be used for an exhaust blower.

34.5 *Leak Test*—To check the apparatus for leaks, the specimen mount cavity shall be sealed with masking tape. With all valves closed, turn on the exhaust blower to approximately $^1/_3$ power and observe any movement of the manometer. The manometer reading, if any, should not exceed 1 Pa or 0.005 in. of water after a 30-s waiting period. Next, open the valve very slightly for the lowest range flowmeter reading. The flow should be essentially zero as evidenced by less than 3-mm movement of the air flowmeter float from its static position. For the equipment to perform satisfactorily over its entire range the requirements for both parts of the leak test must be met.

35. Test Specimens

35.1 The test specimens shall be right prisms cut to fit the mount cavity of the apparatus. A cavity 50 by 50 mm requires a specimen 51.0 ± 0.3 by 51.0 ± 0.3 by 25.0 ± 0.5 mm in size. The 1.98 by 1.98-in. cavity requires a specimen 2.00 + 0.02, −0.01 by 2.00 + 0.02, −0.01 in. by 1.00 ± 0.02 in. in size. A band saw with a movable table and a double bevel knife-edge blade is recommended for cutting the specimens.

35.2 Three specimens per sample for each location and orientation to be tested shall be cut. The values reported shall be the mean of those observed for each location and orientation.

36. Procedure

36.1 Measure each specimen in accordance with the procedure described in Section 4 to verify the specimen size.

36.2 Impress the specimen into the test cavity. Make sure that a good air seal is obtained along all edges. The top of the specimen should be flush with the top of the test chamber.

36.3 With all valves closed, adjust the voltage control of the apparatus to 30 percent.

36.4 Open one flow-control valve slowly until a pressure differential of 100 to 150 Pa (0.4 to 0.6 in. of water) is obtained. Adjust the voltage control carefully to obtain a pressure differential of 125 ± 1 Pa (0.500 ± 0.005 in. of water).

36.5 After this pressure differential has been maintained for at least 10 s, read the scale of the flowmeter.

36.6 If this reading is off-scale or less than 10 percent of full-scale, close that flow-control valve and open a more appropriate one. Repeat this process until the proper manometer reading and air flow is achieved.

36.7 The air flow valve may be obtained from the flowmeter scale directly, estimated from a calibration chart, or calculated with a factor depending on the calibration system.

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[5] Apparatus having a 1.98- by 1.98-in. cavity will give results approximately 1 percent greater than the apparatus having a 50 by 50-mm cavity.

37. Report

37.1 The report shall include the following:

37.1.1 Location and orientation of each specimen with respect to foam rise in the section of foam which was sampled,

37.1.2 Mean air flow value in m^3/s (ft^3/min) for each location and orientation,

37.1.3 Dimensions of the specimen, and

37.1.4 Dimension of the mount cavity of the apparatus.

38. Accuracy

38.1 The accuracy of the air flow value is about ±5 percent.[3]

SUFFIX TESTS

COMPRESSION LOAD DEFLECTION TEST (SUFFIX D)

39. Summary of Method

39.1 This test consists of measuring the load necessary to produce a 25 percent compression over the entire top area of the foam specimen.

NOTE 6—Compression deflection tests other than at 25 percent may be specified as agreed upon between the manufacturer and the purchaser.

40. Apparatus

40.1 An apparatus having a flat compression foot, larger than the specimen to be tested, connected to a load measuring device and mounted in a manner such that the product or specimen can be deflected at a speed of 0.4 to 6.3 mm/s [(1.0 to 15 in.)/min]. The apparatus shall be arranged to support the specimen on a level horizontal plate which is perforated with 6.0 to 6.5 mm (0.24 to 0.26 in.) diameter holes on 20 mm (0.75 in.) centers to allow for rapid escape of air during the test.

41. Test Specimens

41.1 The test specimen shall have parallel top and bottom surfaces and essentially vertical sides. The thickness shall be no greater than 75 percent of the minimum top dimension.

41.2 Specimens from uncored stock shall be a minimum of 25 cm^2 (4 $in.^2$) in area and a minimum thickness of 20 mm (0.75 in.). Specimens less than 20 mm thick shall be plied up, without the use of cement, to a minimum of 20 mm.

41.3 Specimens from cored stock shall be of such size that the coring does not appreciably affect the compression value.

42. Number of Specimens

42.1 Three specimens per sample shall be tested. The values reported shall be the mean of those observed. If any value deviates more than 20 percent from this mean, two additional specimens shall be tested and the mean for all five values shall be reported.

43. Procedure

43.1 Preflex the specimen twice, 75 to 80 percent of its original thickness. Then allow the specimen to rest for a period of 10 ± 5 min.

43.2 Place the specimen centered in the line of the axial load on the supporting plate of the apparatus. In case the product has one side cored or honeycombed, rest this face on the perforated plates.

43.3 Bring the compression foot into contact with the specimen and determine the thickness after applying a total preload of 140 Pa (0.02 psi) of the specimen area (Note 7). Compress the specimen 25 percent of this thickness at 5 cm (2 in.)/min and observe the final load after 1 min.

NOTE 7—For super-soft foam, a reduction of pressure on the compression foot shall be allowed.

44. Report

44.1 Report the thickness after preload and the compression result, in kilopascals (or pounds per square inch) of the specimen area, as the load required for 25 percent compression per square meter (or square inch) of specimen area.

DRY HEAT TEST (SUFFIX A)

45. Summary of Method

45.1 This test consists of exposing foam tensile specimens in an air-circulating oven and observing the effect on tensile properties of the foam.

46. Apparatus

46.1 The apparatus specified in Sections 82 to 88, Tension Test (Suffix T), shall be used for determining tensile values.

46.2 *Air-Circulating Oven* capable of maintaining 140 ± 1.2 C (284 ± 3 F) shall be used for exposing the specimens. A device for sensing and recording the temperature of the oven at least every 2 h shall be attached.

46.3 *Sealed Container*—The specimens shall be suspended in a sealed container of sufficient size, so that specimens do not touch each other or the container. One vent hole, 3.2 mm (0.125 in.) in diameter shall be placed in the removable top. The container shall be constructed of material capable of withstanding the test temperature without exuding any corrosive substance. A tin-plated 1-gal can has been found suitable. A separate container must be used for each different sample. The specimens shall be suspended on a fine wire mounted at the top of the container.

47. Test Specimens

47.1 Test specimens shall be prepared as in Sections 82 to 88, Tension Test (Suffix T).

48. Number of Specimens

48.1 At least three specimens per sample shall be exposed and tested for tensile strength. Three more specimens cut from the same area of the sample shall be used for determining the original tensile strength. The values reported shall be the mean of those observed. If any value deviates more than 20 percent from this mean, two additional specimens shall be tested and the mean for all five values shall be reported.

49. Procedure

49.1 After determining the cross-sectional dimensions, suspend the test specimens in the container and place in the oven at 140 C (284 F). Expose the specimens for 22 h. Obtain and record the oven temperature near the specimen container at least every 2 h.

49.2 Remove the specimens from the container and condition for not less than 12 h at 23 ± 1.1 C (73.4 ± 2 F) and 50 ± 2 percent relative humidity.

49.3 Test for tensile strength in accordance with Sections 82 to 88, Tension Test (Suffix T).

50. Calculations

50.1 Calculate the percentage change in tensile strength as follows:

$$\text{Tensile strength change, percent} = [(S_o - S_f)/S_o] \times 100$$

where:

S_o = mean tensile strength of the unexposed specimens, and

S_f = mean tensile strength of the exposed specimens.

51. Report

51.1 Report the percentage change in tensile strength.

FATIGUE TEST (SUFFIX H)

52. Scope

52.1 The fatigue test recognizes only two methods, Procedure A, Static Fatigue at a Constant Deflection, and Procedure B, Dynamic Fatigue by the Roller Shear at Constant Load.

Procedure A

53. Scope

53.1 The purpose of the fatigue test is to determine, (*1*) a loss of load bearing properties, (*2*) a loss of thickness, and (*3*) structural breakdown by visual examination.

53.2 This procedure tests the specimen statically at a 75 percent constant deflection.

54. Apparatus

54.1 The apparatus shall consist of two parallel plates (wood or metal) which can produce a uniform, constant deflection of the specimen. The plates shall be 500 by 500 mm square (20 by 20 in. square) and spacer bars shall be available to produce 75 percent deflection.

55. Test Specimen

55.1 The test specimen shall be 380 by 380 mm (15 by 15 in.) by the desired thickness. One specimen shall be tested.

56. Initial Measurements

56.1 Measure the specimen for thickness as indicated in Section 4 and for load deflection as indicated in 19 to 25.

57. Final Measurements

57.1 Thirty minutes after the fatigue test is completed, measure the specimen for thickness as indicated in Section 4 and for load deflection as indicated in 19 to 25.

57.2 Repeat the preflexing of the specimen and use the original specimen thickness in determining the deflection. If the loss in thickness is above 10 percent, the load loss would be indeterminate and only the thickness loss should be reported.

58. Procedure

58.1 Place the specimen between the plates with the spacer bars to provide a 75 percent deflection. Clamp the plates and hold at 75 percent deflection for 17 h at 23 ± 1.1 C (73.4 ± 2 F) and 50 ± 2 percent relative humidity.

59. Calculations

59.1 Check the specimen for physical breakdown of the cellular structure by visual examination and comparison with unflexed specimens.

59.2 Calculate the percentage loss of thickness as follows:

$$F_t = \frac{t_o - t_f}{t_o} \times 100$$

where:

F_t = loss in thickness, percent,
t_o = original specimen thickness, and
t_f = final specimen thickness.

59.3 Calculate the percentage loss of load deflection, as follows:

$$F_L = \frac{L_o - L_f}{L_o} \times 100$$

where:

F_L = loss of load deflection, percent,
L_o = original load deflection value, and
L_f = final load deflection.

60. Report

60.1 The report shall include the following:

60.1.1 Percentage loss of thickness and the percentage loss of load deflection if the thickness loss is less than 10 percent, and

60.1.2 Results of visual examination.

Procedure B

61. Scope

61.1 The purpose of this fatigue test is to determine (*1*) a loss of load-bearing properties, (*2*) a loss of thickness and (*3*) possible structural breakdown by visual examination.

61.2 This procedure tests the sample dynamically, at a constant load, deflecting the material both vertically and laterally.

62. Apparatus

62.1 *Perforated Base Platen*, 508 by 508 by 9.5-mm (20 by 20 by ⅜-in.), with a finished grind top surface and with perforation of 6.4-mm (0.25-in.) 19.1-mm (0.75-in.) centers covering the center 356 by 356-mm (14 by 14-in.) portion.

NOTE 8—See Appendix A2 for a full description of the test apparatus.

62.2 *Roller*, 457 mm (18 in.) minimum and 76.2 ± 0.127 mm (3 ± 0.005 in.) in diameter made from stainless steel or chrome material having a minimum surface finish of 50 μ in. (3.75 μm). The roller shall be mounted in an offset position (15 ± 3 deg) with suitable means of adjustment for a specified loading of the test specimen. The mass of the roller assembly shall not exceed 11.35 kg (25 lb).

62.3 The test is conducted at the rate of 28 ± 2 cpm. A cycle is a complete forward and reverse stroke. The length of the stroke shall be 330 ± 12.5 mm (13 ± ½ in.).

62.4 Any suitable method for holding the test specimen securely on the roller base platen is acceptable as long as the test specimen remains stationary during the rolling flex cycles. An acceptable method for retaining the specimen on the base platen is described as follows: Four 50 to 75-mm (2 to 3-in.) wide cotton sheeting strips or paper masking tape at least as long and as wide as the test specimen shall be required. Bond the cotton strips (with a solvent or water emulsion type of adhesive) or the masking tape along the edges of one surface of the test specimen. Allow 25 to 50 mm (1 to 2 in.) of each strip to extend beyond the edges of the test specimen so that the specimen can be securely clamped to the base platen through the use of suitable metal retainer straps.

63. Test Specimen

63.1 A specimen 380 mm (15 in.) long by either 305 or 380 mm (12 or 15 in.) wide (as agreed on between the purchaser and the manufacturer) by the desired thickness is used.

63.2 Area dimensions are to be held to ±6.4 mm (±¼ in.) and may be saw cut or die cut; if die cut, sufficient time must be allowed for complete edge recovery (usually 2 h minimum).

63.3 One specimen shall be tested.

64. Initial Measurements

64.1 Bond the holding tape or suitable hold-down cloth to the bottom edges of the specimen so the specimen can be secured to the perforated base platen of the fatigue tester.

64.2 Condition the specimen as in Section 2. Run the test also under the same conditions.

64.3 Place the test specimen on the supporting plate of the constant-load indentor, Section 27. If the sample has one side cored (or honeycombed), this face shall rest on the perforated support plate. For specimens of uniform thickness the position shall be such that the indentation will be made at the center of the specimen. The indentation area shall be suitably identified with a marking pencil so that subsequent indents will be performed at the same place.

64.4 Deflect the test specimen six times using the 34.1-kgf (75-lbf) load at the rate of 200 to 250 mm (8 to 10 in.)/min. Allow the specimen to rest for 5 min ± 15 s in an undistorted and undeflected position.

64.5 Bring the indentor foot into contact with the specimen at 50 mm (2 in.)/min and determine the thickness of the specimen with the 454-gf (1-lbf) load on the 323-cm^2 (50-in.^{2}) indentor foot. Read the gage immediately and not after any drift.

64.6 Apply the 11.35-kgf (25-lbf) load at 50 mm (2 in.)/min to the indentor foot and compress the specimen until the load is carried by the specimen. Determine the thickness at 11.35-kgf load after maintaining the load for 1 min ± 3 s.

64.7 Without removing the specimen apply the 22.7-kfg (50-lbf) weight to the indentor foot and further compress the pad until this weight is carried. After 1 min ± 3 s under load, observe the thickness of the pad at the 22.7-kgf loading.

65. Final Measurements

65.1 Sixty minutes ± 5 min after the fatigue test is completed measure the final gages in accordance with 64.4 to 64.7.

66. Procedure

66.1 Adjust the roller to obtain 13.64 ± 0.23-kgf (30 ± 0.5-lbf) constant load on the foam specimen. This critical measurement may be made by fashioning a lightweight fabric sling around the roller at its center and measuring the force downward while holding the weighing scale vertically over the roller and maintaining the bottom of the roller at approximately the initial 11.4-kgf (50-lbf) gage position.

66.2 Mount the test specimen on the base platen with the length parallel to the stroke of the dynamic fatigue machine and secure by means of the tape and the metal retainer strips. When mounting cored pieces, coring is to be against the platen. Set the counter to zero, start the machine and fatigue test the sample for 20,000 cycles (40,000 flexes).

67. Calculations and Inspection

67.1 Check the specimen for physical breakdown of cellular structure by visual examination and comparison with unflexed similar specimens.

67.2 Calculate and report the percent of loaded height loss under *Pf*, preflex, load as follows:

$$\frac{(\text{Original } Ga \text{ at } Pf) - (\text{Final } Ga \text{ at } Pf)}{\text{Original } Ga \text{ at } Pf} \times 100 = \text{percent loss}$$

where:

Pf = 454 gf (1 lbf), 11.35 kgf (25 lbf), and 22.7 kgf (50 lbf), respectively, and Ga = gage.

67.3 Calculate the total loss number as follows:

Total loss number = sum of percent losses at each load

Sample calculation:
Percent height loss at 454 gf (1 lbf) = 2.0
Percent height loss at 11.35 kgf (25 lbf) = 18.0
Percent height loss at 22.7 kgf (50 lbf) = 27.0
Total loss number = 47.0

68. Report

68.1 The report shall include the following:

68.1.1 Results of visual examination,

68.1.2 Thickness of the specimen,

68.1.3 The percent height loss at each level of *Pf*, and

68.1.4 Total loss number.

DENSITY TEST (SUFFIX W)

69. Scope

69.1 This method covers determination of the density of uncored foam by calculation from the weight and volume of a regularly shaped specimen.

70. Test Specimens

70.1 A representative specimen of regular shape, not less than 16 cm^3 in volume, shall be cut from the sample to be tested.

70.2 If the entire sample to be tested meets the requirements described in 76.1, it may be used in its entirety for the density determination.

71. Number of Specimens

71.1 One specimen shall be tested.

72. Procedure

72.1 Weigh the specimen on a balance or scale graduated so as to permit weighings within ±1 percent of the mass to be measured.

72.2 Determine the dimensions of the specimen in accordance with Section 4.

73. Calculations

73.1 Calculate the density in pounds per cubic foot, as follows:

$$\text{Density, lb/ft}^3 = M/V \times 0.0624$$

where:

M = mass of specimen, kg, and

V = volume of specimen, m^3.

73.2 If measurements are more conveniently made in the metric system, calculate the density and convert it to British units, as follows:

$$\text{Density, lb/ft}^3 = (M/V) \times 62.4$$

where:

M = mass of specimen, g, and

V = volume of specimen, cm^3.

74. Report

74.1 Report density to the nearest 0.0016 g/cm^3 (0.1 lb/ft^3).

TEAR RESISTANCE TEST (SUFFIX G)

75. Scope

75.1 This method covers determination of the tear resistance of foam. The block method, as described, produces a value which may be regarded as a measure of the tear resistance under the conditions of this particular test.

76. Apparatus

76.1 Tear resistance shall be measured on a power-driven apparatus which will indicate the final load at which rupture of the specimen takes place. An automatic machine may be used which draws the actual curve; or, a style of scale shall be used having an indicator which remains at the point of maximum load after rupture. The rate of travel of the power-actuated grip shall be 51 to 510 mm (2 to 20 in.)/min and uniform at all times.

77. Test Specimens

77.1 The test specimens free of skin voids and densification lines shall be a block shape as shown in Fig. 1. They may be cut on a saw or die cut from sheet material, so that opposite sides are parallel and adjacent sides are perpendicular to each other. A 38.1-mm (1.5-in.) cut parallel to the direction of blow (unless otherwise specified) shall be placed in one side as shown in Fig. 2.

78. Number of Specimens

78.1 Three specimens per sample shall be tested. The values reported shall be the median of those tested. If any value deviates more than 20 percent from this median, two additional specimens shall be tested and the median for all five values shall be reported.

79. Procedure

79.1 Clamp the test specimen in the jaws of the testing machine taking care that the jaws grip the specimen properly. Spread the block so that each tab is held in the jaw to pull across the specimen. Apply the load with a jaw speed of 51 to 510 mm (2 to 20 in.)/min. Aid the cut in the specimen with a razor blade or knife, so as to keep it in the center of the block. After the rupture of the specimen, or after, at least, a 51-mm (2-in.) length is torn, record the maximum reading on the dial or scale, and note also the thickness of the specimen (direction *A-B*).

80. Calculation

80.1 Calculate the resistance to tear from the maximum load registered on the testing machine and the average thickness of the specimen (direction *A-B*).

81. Report

81.1 Report tear resistance in kilograms-force per lineal centimeter (or pounds-force per lineal inch) of thickness.

TENSION TEST (SUFFIX T)

82. Scope

82.1 This method determines the effect of the application of a tensile load to foam. Measurements are made for tensile stress, tensile strength, and ultimate elongation.

83. Apparatus

83.1 *Dies*—The specimen for tension tests shall be stamped out with a die of the shape and dimensions shown in Fig. 3. The die shall be sharp and free of nicks in order to prevent leaving ragged edges on the specimen.

83.2 *Bench Marker*—The marker shall have two parallel marking edges 1.6 mm ($\frac{1}{16}$ in.) in thickness, and spaced 25 mm (1 in.) apart on centers.

83.3 *Measurements*—The dimensions of the test specimen shall be determined with a suitable gage in accordance with Section 4.

83.4 *Testing Machine*—Tension tests shall be made on a power-driven machine complying with the following requirements:

83.4.1 The machine shall be of such capacity as to allow the specimen to break at practically three fourths of its total value or maximum sensitivity. It shall be equipped with a dial or scale indicator that will remain at the point of maximum load after rupture of the specimen and will measure the applied tension at that point. Rate of travel of a power-actuated grip shall be 8.5 + 0.4 mm/s (20 ± 1 in.)/min and shall be uniform at all times.

83.4.2 The machine may be equipped with a device graduated to 25 mm (0.1 in.) for measuring the elongation. For testing dumbbell specimens, the machine shall have either screw-type flat plate grips or a type of grip which tightens automatically and exerts a uniform pressure across the gripping surfaces increasing as the tension increases to prevent slipping.

84. Test Specimens

84.1 The test specimens shall be cut from flat sheet material 12.7 ± 1.6 mm (0.500 ± 0.0625 in.) thick. The top and bottom surfaces shall be parallel and free of skin. The cut edges shall be perpendicular to the top surface and be free of ragged edges. The specimens shall be die cut either parallel to or across the direction of rise of the foam and shall be so specified. The length of the tabs may be adjusted to fit machine conditions provided that all other requirements remain constant.

85. Number of Specimens

85.1 Three specimens per sample shall be tested. The values reported shall be the median of those observed. If any value deviates more than 20 percent from this median, two additional specimens shall be tested, and the median for all five values shall be reported.

86. Procedure

86.1 Set the grip separation at 63.5 mm (2.5 in.) minimum. Place the dumbbell tabs in the grips of the testing machine, using care to adjust them symmetrically, in order that the tension will be distributed uniformly over the cross section. Start the machine and note continuously the distance between the two bench marks, determining the elongation. Record the stress at the corresponding elongation or if an automatic recording device is used, it will record the data continuously. At rupture, measure or record elongation to the nearest 2.54 mm (0.1 in.).

87. Calculation

87.1 Calculate the tensile strength by dividing the breaking load by the original cross-sectional area of the specimen.

87.2 Calculate the stress by dividing the load at a predetermined elongation, by the original cross-sectional area of the specimen.

87.3 Calculate the ultimate elongation by subtracting the original distance between the bench marks in millimeters (or inches) from the total distance between the bench marks at the time of rupture and expressing the difference as a percentage of the original distance, as follows or use the grip separations in a similar calculation:

$$\text{Ultimate elongation, percent} = [(d_f - d_o)/d_o] \times 100$$

where:

d_o = original distance between bench marks, mm (or in.), and

d_f = distance between bench marks at the break point, mm (or in.).

87.4 The value reported shall be the median value of all specimens tested.

88. Report

88.1 The report shall include the following:

88.1.1 Tensile strength in pascals (or pounds per square inch),

88.1.2 Stress in pascals (or pounds per square inch) at a predetermined elongation, and

88.1.3 Ultimate elongation, in percent.

RESILIENCE (BALL REBOUND) TEST (SUFFIX R)

89. Scope

89.1 The ball rebound test is one of several tests that may be adapted for use in evaluating the resilience of foams.[6] This test consists of dropping a steel ball on a foam specimen and noting the height of rebound.

90. Apparatus

90.1 The ball rebound tester shall consist of a 38-mm (1.5-in.) inside diameter vertical clear plastic tube, such as acrylic, into which a 15.9-mm (0.625-in.) diameter (mass 16.3 g) steel ball is released by a magnet or other device. The steel ball must be released so that it falls without rotation. Centering of the ball is assured by a recess at the base of the magnet. The height of drop shall be 457 mm (18 in.) Since it is most convenient to note the position of the top of the ball on rebound, the top of the ball shall be 473 mm (18.625 in.) above the surface of the foam. Thus, "zero" rebound shall be 15.9 mm (0.625 in.) (diameter of the ball) above the specimen surface. The scale on the back of the tube shall be calibrated directly in percent as follows. Every 5 percent a complete circle shall be scribed and every 1 percent a 120-deg arc shall be scribed. The complete circles are an essential part of the apparatus, since they are used to eliminate parallax error.

91. Test Specimens

91.1 The test specimens shall have parallel top and bottom surfaces.

91.2 The test specimen shall consist of the entire product sample or a suitable portion of it, except that in no case shall the thickness be less than 50 mm (2 in.), or the area less than 102 by 102 mm (4 by 4 in.). Specimens less than 5.08 cm (2 in.) thick should be plied up without the use of cement, to a minimum of 50 mm (2 in.).

92. Number of Specimens

92.1 Three specimens per sample shall be tested. The three specimens may be obtained by using separate items or different locations on a given item.

93. Procedure

93.1 Center the specimen at the base of the tube and adjust the height of the tube so that zero rebound is 15.9 mm (0.625 in.) above the surface of the foam specimen.

93.2 Mount the steel ball on the release mechanism, then drop it and note the maximum rebound height. If the ball strikes the tube on the drop or rebound, the value obtained is invalid. This condition is usually due to the tube not being vertical or irregularities on the specimen surface. In order to minimize parallax error, the circles on the tube in the region where the percent rebound is read must appear as lines.

93.3 Make an additional two drops on the same specimen.

94. Calculations

94.1 Calculate the mean of the three rebound values. If any value deviates more than 20 percent from this mean, make two additional drops and calculate the mean for all five drops.

95. Report

95.1 Report the average of the three specimen means as the Ball Rebound Resilience Value of the sample in percent.

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[6] Modifications of other methods include the ASTM Method D 1054, Test for Impact Resilience and Penetration of Rubber by the Rebound Pendulum and Methods D 945, Tests for Mechanical Properties of Elastomeric Vulcanizates Under Compressive or Shear Strains by the Mechanical Oscillograph, which appear in the *1974 Annual Book of ASTM Standards*, Part 37.

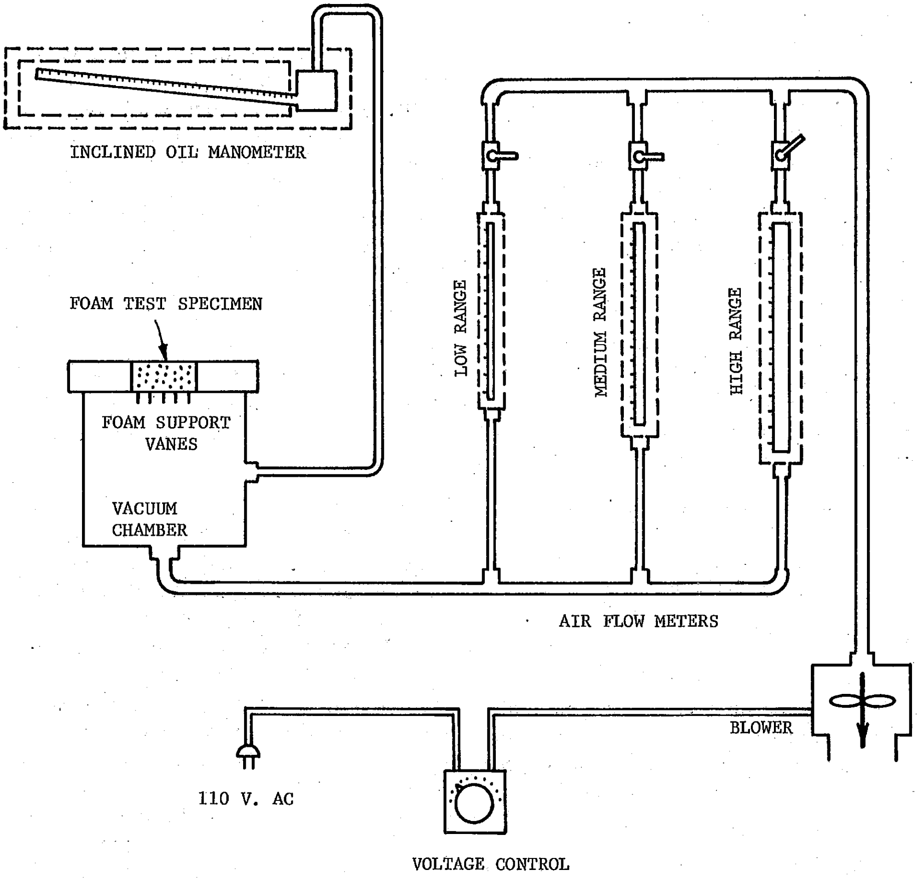

FIG. 1 Air Flow Apparatus Schematic Diagram.

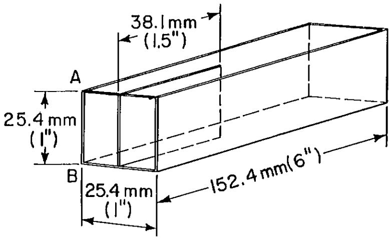

FIG. 2 Tear Resistance Test Specimens.

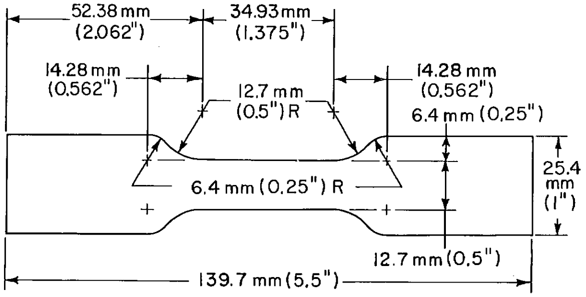

FIG. 3 Die for Stamping Tension Specimens.

APPENDIXES

A1. SUGGESTED METHOD FOR SPECIFYING FLEXIBLE URETHANE FOAM

A1.1 The suggested practice for specifying flexible urethane foam is:

USU—Urethane Slab Uncored
USC—Urethane Slab Cored
UMU—Urethane Molded Uncored
UMC—Urethane Molded Cored

Digits following the number specify the firmness grade and the letters following that specify type of load deflection test.

A1.2 Suffix letters may be added singly or in combination after the above to indicate additional requirements (Sections 32 to 94), beyond those specified as Basic Tests (Sections 6 to 31). The values for these suffix tests are to be arranged between the supplier and the purchaser.

A1.3 *Example:* USU 30 ILD G T R

The foam is a urethane slab uncored with a 30-lb Indentation Load Deflection value at 25 percent deflection. Minimum value tear (G), tension (T), and resilience values (R) have been agreed upon.

A2. SUGGESTED METHOD OF CONSTRUCTION FOR A ROLLER SHEAR DYNAMIC FLEX FATIGUE APPARATUS

A2.1 The following requirements are established to define the equipment and relationship of parts for a constant-load roller shear machine. See Figs. A1 and A2 for reference to part numbers.

A2.2 *Roller*, 1:

A2.2.1 Dimensions—457-mm (18-in.) minimum length, and 76.20 ± 1.27-mm (3.00 ± 0.05-in.) diameter.

A2.2.2 *Material*—corrosion and wear resistant metal, either (1) chrome plated material, or (2) stainless steel.

A2.2.3 *Surface Finish*—Finish surface on roller is to be ground and equivalent to at least 0.001 mm (50 μin).

A2.2.4 The mass of the roller shall not exceed 11.340 kg (25 lb).

A2.3 *Roller Mounting Bracket Assembly*, 2, 3, 4, 11:—The assembly consists of metal members designed to attach the roller to a pivot point, to provide bearing surfaces for minimum friction for turning, and to serve as a platform to add required mass to the roller.

A2.3.1 *Bearings*, 2 and 4—The proper bearings are required on each end or roller axis (A-A) and also on the pivot axis (B-B). The bearings should be equivalent to the following example:

Bearing No. 4—Nice No. 1635, DC Ball Bearing 19 by 32 by 13 mm (¾ by 1¼ by ½ in.)

Bearing No. 2—Nice No. 6906, flange mounted radial bearing

NOTE A1—Roller axis bearings may be mounted in the bracket with the axle attached to the roller or, if the roller is a hollow cylinder, the bearing may be press fit into the cylinder end with the bracket furnishing the axle.

A2.3.2 *Pivot Arm*, 11—The distance between the pivot axis and the roller axis shall be 203.20 ± 6.35 (8 ± ¼ in.)

A2.3.3 *Roller Bracket Connector*, 3—connects the right and left bearing brackets across the top of the roller. The connection must also provide a flat horizontal surface with means (pin) to attach the weights. The weights must be centered directly above the axis of the roller.

A2.3.4 *Axis Relationship*—The roller axis (*A-A*) and pivot axis (*B-B*) must be parallel and lie in the same horizontal plane parallel to the specimen mounting base.

A2.3.5 *Alignment and Clearance*—Brackets and axles must be aligned so that no binding occurs to obstruct free turning on either axis. Brackets and other support members (5) must give free clearance so that specimen is not touched during test other than by roller surface.

A2.3.6 *Weight*, 6—The total vertical force exerted by the assembly plus the roller should not exceed 111 N (25 lb) as measured at a point directly above or below the roller axis when both roller and pivot axes are in the same horizontal plane (A2.3.4). Additional weights to be added as shown.

A2.3.7 *Vertical Adjustment*, 7—If the roller is not driven to provide stroke movement, provision should be made so that attachment of the pivot axis to the support can be raised or lowered at least 75 mm (3 in.). This adjustment must be able to be made in not less than 12.5 mm (½ in.) increments.

A2.4 *Specimen Mounting Base*, 8:

A2.4.1 *Dimensions*—500 mm (20 in.) minimum length, 500 (20 in.) minimum width, and 9.5 mm (⅜ in.) minimum thickness.

A2.4.2 *Material*—structural grade carbon steel

A2.4.3 *Perforation*—6 mm (¼ in.) diameter holes on 20 mm (¾ in.) centers, over a minimum area covering 350 mm (14 in.) in length by 350 mm in width.

A2.4.4 *Surface Finish*—top surface shall be a finish grind.

A2.4.5 *Hold-Down Plates*, 9—Provision to attach metal or wood hold-down plates for clamping cotton sheeting retaining strips to base. Four plates are required to cover perimeter of specimen size.

A2.4.6 *Vertical Adjustment and Level*, 10—If mounting base is not driven to provide stroke movement, provision should be made for vertical adjustment of at least 75 mm (3 in.). This adjustment must be able to provide vertical movement in not less than 12.5-mm (½-in.) increments and maintain a horizontal level condition of the mounting base.

A2.5 *Mechanical Requirements:*

A2.5.1 *Stroke Length*—The length of stroke shall be 330 ± 12 mm (13 ± ½ in.).

A2.5.2 *Stroke Speed, Stroke Drive*—The rate of stroke speed should produce 0.47 ± 0.03 Hz (28 ± 2 cpm). A cycle is a complete forward and reverse stroke. Either the roller or the mounting base may be driven to produce stroke travel. In either case, the drive mechanism must produce travel in a horizontal plane.

A2.5.3 *Angular Offset*—The axis of the roller should be level and mounted at a 15 ± 3-deg offset from perpendicular to the direction of the stroke.

A2.5.4 *Mounting Base Location*—The length of the mounting base should be the parallel to the direction of the stroke and centered under the midpoint of the stroke and the center of the roller. The distance of the base surface from the roller axis (A2.3.4) should be 45 mm (1¾ in.) when vertical adjustment provides a minimum clearance.

A2.5.5 *Cycle Counter*—Means to record the number of cycles should be provided.